REPORT OF SURVEY CONDUCTED AT

LITTON
APPLIED TECHNOLOGY DIVISION

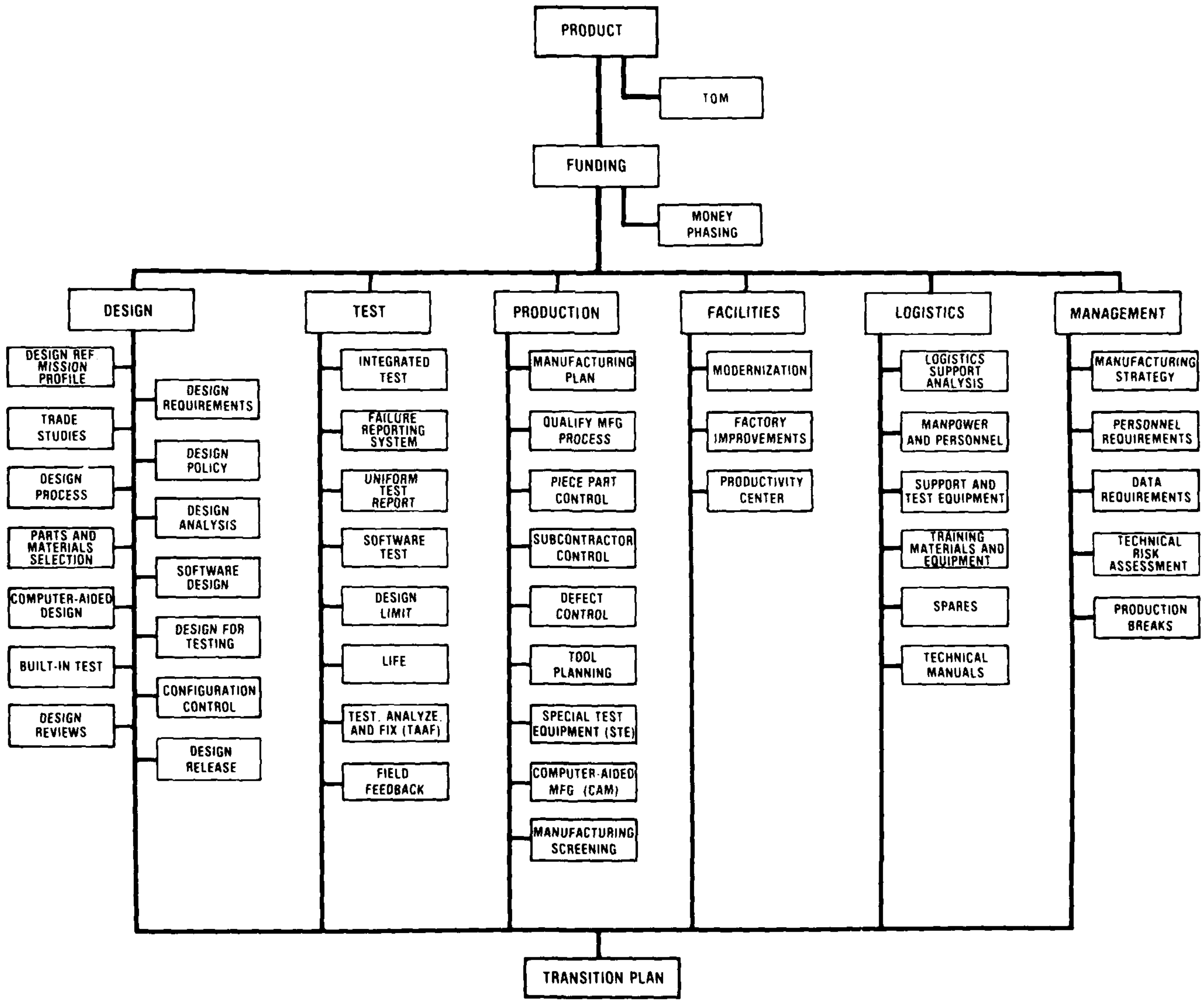
SAN JOSE, CALIFORNIA

APRIL 1989

DoD 4245.7-M

"TRANSITION FROM DEVELOPMENT TO PRODUCTION"

CRITICAL PATH TEMPLATES



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The purpose of the Best Manufacturing Practices (BMP) survey conducted at this facility was to identify their best practices, review manufacturing problems, and document the results. The intent is to extend the use of progressive management techniques as well as high technology equipment and processes throughout the U.S. industrial base. The actual exchange of detailed data will be between contractors at their discretion. A company point of contact is listed in the report

The intent of the BMP program is to use this documentation as the initial step in a voluntary technology sharing process among the industry.

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SECTION 1

EXECUTIVE SUMMARY

The Best Manufacturing Practices (BMP) team conducted a survey at Litton, Applied Technology Division (ATD) located in San Jose, California. The purpose of the survey was to review and document the best practices and potential industry-wide problems at Litton ATD. The intent of the BMP program is to use this documentation as the initial step in a voluntary technology sharing process among the industry.

1.1 KEY FINDINGS

There were many best practices observed at Litton ATD that are detailed in this report. Some of the more significant findings included in this report are listed below:

Item	Page
Use of Ultra-Violet Curable Materials in Manufacturing Investigation in the use of UV curable materials for potting of connectors, wire and tacking of components, and conformal coating of PCAs	11
Adaptive Stress Screening Random vibration performed in conjunction with Environmental Stress Screening temperature cycling	14
Test Equipment Loan Pool/Lending Library Centralized pool for control of test and measurement equipment	15
Best Manufacturing Practices Implementation Evaluation, establishment of an organization, training, development of policies/procedures, and implementation of DoD 4245.7-M	19

SECTION 2

INTRODUCTION

2.1 SCOPE

The purpose of the Best Manufacturing Practices (BMP) survey conducted at Litton, Applied Technology Division (ATD) was to identify best practices, review manufacturing problems, and document the results. The intent is to extend the use of progressive management techniques as well as high technology equipment and processes throughout industry. The ultimate goal is to strengthen the U.S. industrial base, solve manufacturing problems, improve quality and reliability, and reduce the cost of defense systems.

To accomplish this, a team of Navy engineers supported by a representative of the Army accepted an invitation from Litton ATD to review the most advanced manufacturing processes and techniques used in their facilities located in San Jose, California. Manufacturing problems that had the potential of being industry wide problems were also reviewed and documented for further investigation in future BMP surveys. The review was conducted on 25-28 April 1989 by the team identified in Appendix B of this report.

The results of BMP surveys are entered into a data base to track best practices and manufacturing problems. The information gathered is available for dissemination through an easily accessible central computer. The actual exchange of detailed data will be between contractors at their discretion.

The results of this survey should not be used to rate Litton ATD among other defense electronics contractors. A contractor's willingness to participate in the BMP program and the results of a survey have no bearing on one contractor's performance over another's. The documentation in this report and other BMP reports is not intended to be all inclusive of a contractor's best practices or problems. Only selected non-proprietary practices are reviewed and documented by the BMP survey team.

2.2 SURVEY PROCESS

This survey was performed under the general survey guidelines established by the Department of the Navy. The survey concentrated on the functional areas of design, test, production, facilities, logistics, and management. The team evaluated Litton ATD's policies, practices, and strategies in these areas. Furthermore, individual practices reviewed were categorized as they relate to the critical path templates of the DoD 4245.7-M, "Transition From Development To Production." Litton ATD identified potential best practices and potential industry wide problems. These practices and problems and other areas of interest identified were discussed, reviewed, and documented for dissemination throughout the U.S. industrial base.

The format for this survey consisted of formal briefings and discussions on best practices and problems. Time was spent on the factory floor reviewing practices, processes, and equipment. In-depth discussions were conducted to better understand and document the practices and problems identified.

2.3 NAVY CENTERS OF EXCELLENCE

Demonstrated industry wide problems identified during the Best Manufacturing Practices surveys may be referred to one of the Navy's Manufacturing Technology Centers of Excellence. They are:

Electronics Manufacturing Productivity Facility (EMPF)
Ridgecrest, CA

Applied research in the processes and materials involved in the manufacture of circuit card assemblies

Automated Manufacturing Research Facility (AMRF)
Gaithersburg, MD

Applied research in the machining processes, within a heterogeneous Computer Integrated Manufacturing environment

Metalworking Technology Incorporated (MTI)
Johnstown, PA

Applied research in the metalworking processes

2.4 LITTON ATD OVERVIEW

Litton ATD is a fully integrated designer and producer of electronic components and complete systems primarily for military applications. The Division's Hybrid Microwave Devices (HMD) development and manufacturing facilities occupy 42,000 square feet in the San Jose, California headquarters complex; and the Division's primary system and test area occupies 100,000 square feet in the nearby Sunnyvale facility.

Litton ATD has been a major supplier of radar threat warning systems to the USAF, USN, NATO, and other free world nations for nearly 25 years, and has built and supported over 20,000 systems. Besides the threat warning product line, the Division is involved in advanced avionics EW system applications, RF and electro-optic (EO) sensors for tactical targeting systems, space computers and detectors, support equipment, software development, and threat simulation systems.

The Litton ATD Division headquarters in San Jose has over 350,000 square feet of floor space and provides centralized management for all programs and management functions. The facility houses all Division hardware and software design and advanced development activities and the associated CAE/CASE tools. A number of special development and test laboratories are maintained to support Division activities including VLSI, RF, EO, and RF simulation applications. A first article fab and assembly area covering approximately 5,000 square feet is used to manufacture development models of new equipment, special test equipment, and small quantity runs of production equipment. Material planning and purchasing for all Division facilities is accomplished in San Jose. As mentioned above, HMD equipment fab, assembly and testing is located in the San Jose complex. Production capabilities in the HMD area include the printing and firing of thick film ceramic substrates of up to 7 layers with 10 mils line width, microprocessor controlled die attachment and wire bonding, hermetic hybrid sealing with a resistance seam welder on packages of up to 8" by 8", and a microprocessor based 3 axis hermetic laser weld sealer for the aluminum housings on MIC devices.

The Sunnyvale facility is used for planning, manufacturing, and testing recurring production quantities of circuit cards, cables and harnesses, final assemblies, and systems. The building has dedicated areas for material receiving, receiving inspection, material stores, kitting, machining, component preparation, board loading, wave solder, conformal coating, cable and harness assembly, in-process board and harness testing, final electrical testing, environmental testing, anechoic testing, and shipping.

Current production rates for Litton ATD threat warning systems are about 40 systems per month, but rate studies of the Sunnyvale facility indicate that rates of 100 systems per month can be supported. The Sunnyvale facility also has a material and process development laboratory, a worker training and certification center, a CAM and work measurement center maintained by Manufacturing Engineering, and a depot/repair center for Litton ATD products returned after field use. All depot capability for the Navy's AN/ALR-67 radar threat warning system is maintained by Litton ATD in this area.

2.5 ACKNOWLEDGEMENTS

Special thanks are due to all the people at Litton ATD whose participation made this survey possible. In particular, the BMP Program acknowledges the special efforts of Mr. Thomas Michalski, President of Litton ATD, and Mr. Jerry Everman, Vice President of Program Management, for enabling this survey to occur.

2.6 LITTON ATD POINT OF CONTACT

While the information included in this report is intended to be descriptive of the best processes and techniques observed at Litton ATD, it is not intended to be all inclusive. It is anticipated that the reader will need more detailed data for true technology transfer.

The point of contact for this BMP survey is:

Mr. Dean Knisley
Program Manager
(408) 365-4277

Litton Applied Technology Division
4747 Hellyer Avenue
P.O. Box 7012
San Jose, CA 95150-7012

Mr. Knisley's cooperation, time, and quality of effort in preparation and hosting of this survey at Litton ATD and participation in the Best Manufacturing Practices Program is greatly appreciated.

SECTION 3

BEST PRACTICES

The practices listed in this section are those identified by the BMP survey team as having the potential of being among the best in the electronics industry.

3.1 DESIGN

FORMAL PROCEDURES FOR USE OF ELECTRONIC CAE TOOLS

The Litton ATD processor engineering group has written policies and procedures governing the use of Computer Aided Engineering (CAE) tools. They have written work instructions covering CAE schematic generation, loading analysis, logic simulation, timing analysis, and power calculations. Such policies and procedures are necessary in order to both initiate the transition for use of electronic CAE tools and provide design engineers with guidance and standards for their use.

The Litton ATD processor engineering department has made an early investment in CAE tools for electronic design. Processor engineering's current toolset consists of Analog Design Tool's "Analog Workbench" running on two Sun-2 workstations, schematic capture and digital simulation tools from Valid Logic Systems running on 10 PC-AT and ScaldSystem workstations, and VLSI design and layout tools from VLSI technology running on seven Ridge/VAX/ADE workstations. The valid tools are augmented by two Valid REALFAST simulation accelerators and two Valid REALCHIP hardware modeling engines. All tools and platforms are interconnected by ethernet.

COMPONENT COMMONALITY

Litton ATD is aggressively pursuing the use of common components/assemblies as a method for reducing overall system costs. Emphasis for this effort has been at the corporate level. Litton's effort, begun in early 1988, has concentrated on RF components, printed wiring board (PWBs), integrated circuits (ICs), and power supplies.

Concentrating on the module or substrate level and utilizing a Microwave Integrated Circuit (MIC) component catalog, Litton ATD has successfully implemented this standardization effort for RF components on in-house designed assemblies for various programs. They have had only limited success applying this approach to the PWB arena due to the application specific nature of most PWB designs.

In the IC area, Litton ATD has been able to identify and construct a seven-chip set family for video processor applications in all advanced threat warning systems now under development.

These efforts are good examples of amortizing design, development, fabrication, and test costs of traditionally high cost components over a number of applications, while minimizing risk and schedule impacts to individual programs.

SOFTWARE TOOLS AND TECHNOLOGY

Litton ATD is addressing two of the common problems often found in software design. These problems are that the functional requirements and interfaces are neither totally nor clearly defined and that the overall product software design is not structured, completed, or updated.

Litton ATD contends that good software engineering practices complemented with Computer-Aided Software Engineering (CASE) tools and training support are the major drivers for implementing good engineering practices. They have devoted approximately the last 18 months to the research, evaluation, and acquisition of software tools in the areas of artificial intelligence, CASE tools, and the Ada programming language. They have supplemented this effort with an extensive technology library and training curriculum that includes textbooks, tutorials, and video lecture materials.

In the CASE arena, Litton ATD is pursuing fully integrated tools that provide automated support in areas such as structured analysis, structured design, program design languages, and DOD-STD-2167 support. They are seeking computer-aided not computer-based tools. An evaluation of fourteen tools was recently completed. Three of the CASE tools (VS Designer, EPOS, and ProMod) were selected for additional onsight evaluation, with ProMod being the final selection.

MECHANICAL CAE/CAD

Mechanical engineering design is the responsibility of Litton ATD's Development Engineering Directorate. All new mechanical designs use Computer-Aided Engineering (CAE) and Computer-Aided Drafting (CAD) tools for design and analysis, drafting, and documentation generation and control.

Conceptual and detailed design modeling is accomplished by using Matra Datavision's "Euclid" software for three dimensional (3D) solids modeling. This software supports the individual engineer/designer in other areas such as interference checking and mass property (weight, center of gravity, moments of inertia, etc.) determinations. Additionally, the 3D solid model can be used as the basis for performing both structural, using "PATRAN", and thermal, using "SINDA", analyses run on VAX 11/785 hardware.

ADRA systems' "CADRA" workstations support the drafting and documentation areas. Two dimensional representations of 3D models are transferred from Litton ATD's design/analysis systems to their drafting/documentation systems via an IGES translator. This method provides a fast, user friendly, general drafting capability from design models.

Although analysis data is not electronically archived, both 3D and 2D information is stored in an electronic data base. Preliminary procedures for data base read access after release, backup, data base tracking, storage control, and configuration management/change control are being utilized. Final procedures are being reviewed.

3.2 TEST

FIELD SERVICE COMMUNICATIONS

Litton ATD has established a global communications network linking all of its field service representatives throughout the world directly with division headquarters and with each other. The network is low cost, but provides some very powerful capabilities. Each field representative has a Zenith lap top PC equipped with a 3-1/2" drive, 20 MB hard disk, and communictions modem plus a dot matrix printer. The software includes Wordstar, d-Base, Lotus 1-2-3, Crosstalk, and a graphics package. The representatives communicate via commercial telephone lines and electronic mail through a PC at division headquarters. Although no classified information is transmitted, all data is scrambled to assure privacy.

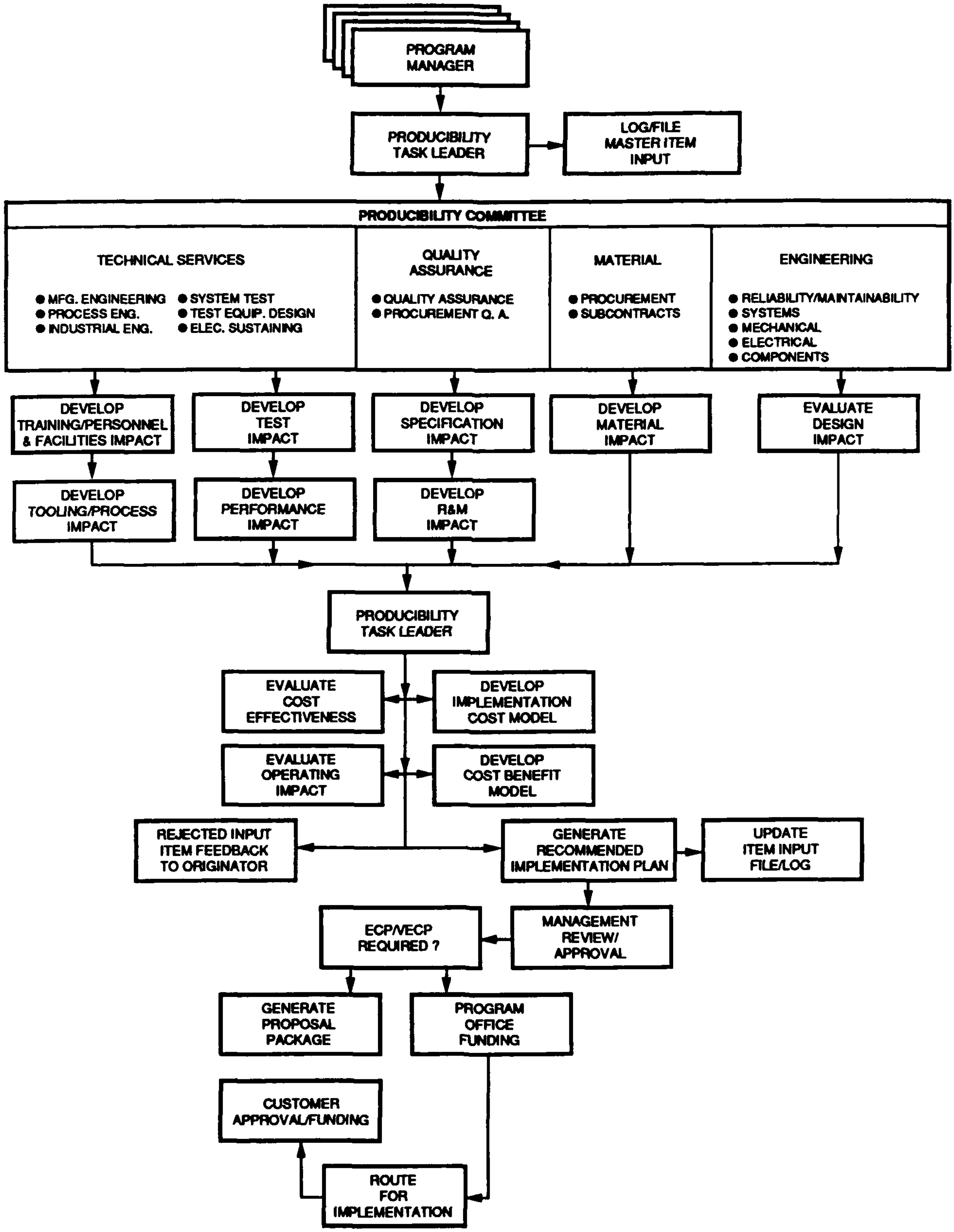
The network is used routinely to provide weekly activity reports, failure reports, and special reports on a real time basis. It provides field representatives with on-site capabilities for word processing, maintaining data base records, report publishing, and portable retaining and retrieval of records. Top management sees all communications over the network. The network is on-line 24 hours a day, 7 days a week.

The system provides rapid, high volume, bi-directional flow of data to ensure that key division management is always informed of product performance and customer needs. Field representative reports are delivered unfiltered to all levels of management to provide instant awareness of action item status and to assure quick response. The network has been in use for eight years at ATD.

3.3 PRODUCTION

PRODUCIBILITY

Litton ATD has established a producibility program that is implemented at the concept stage and continues throughout the production phase of the product. The program designates a producibility task leader who is a member of the operations organization and a producibility program committee consisting of specialists from engineering, reliability, and manufacturing disciplines. The program is implemented with a disciplined approach, where enhancements are suggested via documented forms and the committee acts upon the suggestions. Litton ATD has implemented a computerized assembly planning system and documentation system which allows fast turn around of changes in processes or parts and keeps the factory floor from building any more than one day's run of product to an earlier revision. The system automatically updates all drawings and instructions that relate to a changed part or assembly. The system has a built-in electronic approval system. The system can transfer engineering data into manufacturing assembly instructions. The system has saved 25% of the labor for assembly document generation and 50% of the labor for document maintenance.



PRODUCIBILITY PROGRAM FLOW

USE OF ULTRA-VIOLET CURABLE MATERIALS IN MANUFACTURING

An ongoing study of commercially available, Ultra-Violet (UV) curable single component, solvent free materials has resulted in potentially large savings in manufcturing processes. Three areas of application have been pursued to date by Litton ATD. They are the potting of connectors, wire and component tacking, and PCA conformal coating. Different formulations and curing procedures are required to optimize results for each application. However, curing times are in the seconds range instead of hours. The conformal coatings have been MIL-SPEC (MIL-I-46058) approved. Other materials have been submitted to NWC China Lake, CA for MIL-SPEC approval. Modified urethane potting materials UV cure in 30 - 70 seconds. They are clear so that they allow viewing of the potted items and remain pliable after curing. Since they do not require mixing, they have a long pot life as well as a long shelf life. Materials now in use are 3 BOND 30468, DYMAX 488, and Dymax 20195.

Long curing times and undesirable solvent emissions are eliminated by the use of UV cured materials for conformal coating of PWAs. The long pot life of the coating material almost eliminates spray nozzle cleaning. UV curing time for DYMAX 984 is 10 to 15 seconds. Litton ATD is also experimenting with a precison spray system which could eliminate all pre-coat masking.

Another interesting application of these materials is in the wave soldering of large PCAs. Warpage, common during wave soldering of large boards, is minimized by attaching metal bars as board "stiffeners" with a water soluable, UV cured adhesive. Boards up to 18 by 24 inches have been successfully soldered by this procedure. The metal stiffeners are easily removed during the post-solder water wash.

WAVE SOLDERING PROCESS IMPROVEMENTS

Litton ATD is achieving less than a 1.5% first pass reject rate from their wave soldering process. This is accomplished on a modified Hollis MK II wave soldering machine. Departing from the usual "wave solder-lead trim-wave solder" three step process, Litton ATD preforms and trims component leads prior to board stuffing. Part lifting during wave soldering is eliminated by the lead forming. Through-board lead protrusion of 0.010 inch to 0.040 inch (after wave soldering) is maintained. Thus, a second pass through wave soldering to tin the trimmed leads is eliminated.

Set up values for the wave soldering variables are determined by passing a first article board, with a thermocouple device attached, through the process. Normally, no more than three passes are needed to establish the process values. The "recipe" is stored by part number in the machine memory, which has been augmented with an IBM PC via an RS-232 link.

A modification to the standard Electrovert SC500 machine provides an adjustable, high pressure (0 - 250 psig) solvent defluxing system. Higher than usual (0 - 30 psig) pressures ensure total defluxing under difficult components and eliminates pre-conformal coat ionic contamination problems as confirmed by an Omega meter.

SUPPLIER PERFORMANCE

Since May of 1988, Litton ATD has been implementing a formal program to work with suppliers to reduce non-compliant material, eliminate problems with in-house procurement documents, and improve supplier delivery performance. The ultimate goal of the program is to establish partnership relationships with major suppliers, governed by formal partnership agreements. By identifying and sticking with proven suppliers, ATD intends to greatly reduce the number of its suppliers.

Litton ATD determined that a primary cause of non-conforming material stemmed from poor communication. In most cases, drawing errors or inaccurate interpretation of drawings by suppliers was the source of problems. Pareto analysis was used to identify "bad" commodities and part numbers. Subcontractor Assist Teams composed of QA, R&M, Purchasing, Engineering, and Technical representatives were formed to visit suppliers and work closely with them to resolve drawing, technical, and contractual problems. When changes have been agreed upon and implemented by the supplier, the team reviews and accepts the first article. The team monitors the supplier and rates performance based on quality. Future ratings ae planned to include delivery and service criteria as well as quality. Source inspection requirements are eliminated for suppliers who achieve an acceptable rating. During the past three years, source inspection requirements have been reduced from about 1600 to 130. Receiving inspection requirements will also be reduced or eliminated (i.e., ship to stock) for those suppliers who achieve an acceptable rating. The supplier rating system will be used to adjust quoted prices in order to determine contract awards based on true cost.

To facilitate the development of long term relationships and decrease the number of suppliers, ATD is establishing the "Positive Partnership Program." Elements of the program include: flowdown of TQM to suppliers, up front supplier involvement, team meetings and visits, formal partnership agreements, a preferred supplier list, certification, and ship to stock. Two key computer based PC tools are the Enhanced Performance Rating System and the Enhanced Approved Supplier List. Both will be fully operational by May 1989. The program is coordinated with other Litton divisions for maximum impact.

The division is experiencing many benefits from these initiatives, including improved relationships with suppliers, reduction or elimination of redundant inspection, reduction in unnecessary handling, lower inventory, and improved yields at the next higher assembly.

TESTING OF ASIC DEVICES

Litton ATD designs dense (100,000 transistors) and large (up to 500 mils on a side) Applications Specific Integrated Circuits (ASICs). The number of designs and ASICs procured are not sizeable enough to justify the purchase of expensive parametric test equipment. Instead, Litton ATD contracts with its ASIC suppliers to use ATD generated test vectors to test completed die, thus saving the cost of expensive parametric test equipment and a fault simulation engine.

This activity is an example of Litton ATD's initiatives to make vendors fully responsible for the products that they supply. Litton ATD will implement written partnership agreements with a limited number of ASIC suppliers. The focus of these agreements will be to continuously improve quality while shifting the emphasis from the detection of defects to the prevention of defects.

STATE OF THE HEALTH

Litton ATD has a Total Quality Management (TQM) technique for monitoring and taking corrective action for defects, with a goal of achieving zero defects. Daily meetings are held to discuss failures and failure trends. Corrective actions are taken to eliminate failures from future production. The workers are also drawn in to offer help in resolving problems. The number of defects per worker has been continually declining since 1986. The decline is attributed to factory modernization, employee involvement and feedback, goal setting, new equipment, new factory layouts, providing needed tooling, training and educational opportunities, and the fact that every failure is examined at the lowest level required to fix the problem. Monthly meetings are held to provide high level visibility, up to the vice president level, to problems that have not been corrected. The data is presented as an accumulation of the total number of failures per box sold per month. The monthly average is displayed along with a four month average and a cumulative average. The different averages allow the reviewer to sort out short term variations from longer term trends.

MATERIAL REVIEW ACTIVITIES

As recently as two years ago, Litton ATD was following the traditional practices of using defective material "as is" or employing "non-standard" corrective action practices. Since then, the Litton ATD Total Quality Management (TQM) program has made remarkable progress at reducing defects and Material Review Board (MRB) activities. This progress came about by increasing their awareness of improved practices for defect control versus the traditional acceptance of defective material as "a fact of life". Today, Litton MRB activities are approximately 40% of what they were in 1987 and are continually decreasing.

Litton ATD initiated defect control as a result of increased awareness/concern which centered upon cost, quality, and reliability and the Navy's contract requirement for manufacturing quality data (SECNAVINST 4855.2). Litton ATD changed their approach to defect control management by dropping the traditional MRB activities such as use as is, return to vendor, repair, fact of life, etc. They have adapted new MRB activities consisting of finding the causes of defects, working with suppliers, promoting change, etc. Specific actions at improving process control, such as wave soldering, and the active involvement by management and workers at preventing defects have positively impacted Litton ATD performance.

Because of this concentrated effort to adapt practices for preventing defects, Litton ATD has realized the following benefits:

- Reduced "hidden factory" costs by making it visible to the line and management.
- Improved material flow to production.
- Improved ability to schedule deliveries more accurately.
- Increased manufacturing efficiencies by reducing standard and non-standard repairs.
- Improved quality by reducing the need to "sort for good ones" or determine if it's "good enough".
- Allowed Litton ATD to produce a more competitive product.

WIRE DIRECTOR CENTER

Litton ATD has implemented a wire director system that cuts wiring times from 20 hours to 15 hours on some major assemblies. The system identifies the next wire to install and ensures that the correct wire is selected by peforming a continuity test. The wiring sequence and the successful completions are displayed on a monitor. The system will not let the operator advance if the wrong wire is selected. The system has cut wiring defects to nearly zero, which will allow the elimination of other tests to verify the wiring. The system has a learn mode, which allows new assemblies to be programmed quickly and easily.

TESTER USER INTERFACE

Litton ATD has designed a test system for both high speed digital RF Shop Replaceable Assemblies (SRAs), and Weapons Replaceable Assemblies (WRAs). This system is called the Universal Production/Depot Automatic Test Equipment (UP/DATE).

The notable segment of the system is the user interface developed by Litton ATD for the test operator. The user interface has been implemented using an Apple MacIntosh II. The MacIntosh is used to display graphic images of the layout of the Unit Under Test (UUT), schematics, and component data sheets. When a test failure is detected, the MacIntosh is used to display the associated entries of the fault dictionary. The entries in the fault dictionary are linked to the image of the UUT layout to graphically cue the test operator's guided probe fault investigation. Detailed component data is very useful at this time. Test operators can also leave messages and instructions for operators on following shifts.

The graphical interface is also used to display images of paper forms normally filled out by the test operator. This virtually eliminates the need for test operators to enter repetitive data such as dates, names, time, etc. Test results will be recorded automatically, resulting in higher reporting accuracies.

ADAPTIVE STRESS SCREENING

Litton ATD performs an adaptive stress screening concept on Weapons Replaceable Assemblies (WRAs) which consists of 10 minutes of 6gRMS Random Vibration prior to performing Environmental Stress Screening (ESS) and an adaptive stress screening program. The adaptive stress screening program consists of additional testing performed prior to ESS. The type of testing performed is dictated by the failures that have occurred during ESS. All circuit card assemblies are subjected to 12 one hour cycles of temperature from -55 degrees C to +95 degrees C. Random vibration, depending on the type of assembly, is performed on WRAs. All failures are evaluated with a cause and corrective action identified to prevent recurring failure modes. The number of defects occurring during the process has been continually declining and is showing the benefits of finding the failure at the lower assembly level. The adaptive stress screening is self-imposed, with customer concurrence. The ESS requirements are imposed by contract.

3.4 LOGISTICS

WORK MEASURMENT SYSTEM

Litton ATD has implemented the MANPRO Labor Standards and Product Routing System. The system will create labor standards that satisfy the MIL-STD-1567A requirements. The system is used to measure potential cost savings from changing operations or equipment. The system links the product routings with the labor standards. The system contains a library of time elements for various operations. Changes to any time element or operation are automatically reflected in all labor standards that contain the particular time element or operation. The product routings are generated on the MANPRO system and are electronically distributed. The system has shown a 75% savings over the typical motion-time-measurement systems. The automatic revision of time elements across all labor standards has shown an 80% savings. The system can be used to provide cost savings data to justify the purchase of automated equipment or to determine if it is not economically feasible.

TEST EQUIPMENT LOAN POOL/LENDING LIBRARY

Litton ATD maintains a test equipment "loan pool," which is a collection of test equipment and instruments that is available for temporary use by all departments within the company. The system consists of a centralized computer-based inventory system for all test and measurement instruments at Litton ATD, a storage area for surplus equipment, and accessibility by all departments. Litton ATD recognized the importance of such a system to:

Improve control of the 17,000 instruments in the company.
Reduce the number of informal holding areas which had developed.
Improve communication among departments on types of equipment that are available.
Improve the new capital justification process by eliminating requests for equipment already owned.
Improve capabilities to identify surplus capital.

The Loan Pool maintains an inventory listing that is updated periodically (monthly), easy to access (telephone), and closely controlled. Since the implementation of the program, surplus and obsolete equipment has been easier to identify. Equipment not used for one year is considered surplus or obsolete and is submitted to the property administrator for disposal. Confidence in the program is high. Excess equipment has been readily given up to the pool for use by others, thus optimizing the use of the equipment and reducing lease and purchase costs of new equipment.

Litton ATD policy requires departments to contact the loan pool coordinator prior to starting a new capital asset justification, capital asset requisition, or purchase requisition to see if the item is already available in the loan pool. This eliminates costly and unnecessary paperwork preparation. Additional savings result from the loan pool system because periodic calibration is not performed on equipment during storage, but only just prior to being loaned. Because of the pool, Litton ATD has demonstrated an increased utilization of capital assets, better control in reduction of purchases of capital assets, more efficient manpower utilization, and improved utilization of equipment storage. In the initial year of the loan pool, a $2 million savings was realized.

3.5 MANAGEMENT

INTEGRATED MANAGEMENT SYSTEM

The Integrated Management System (IMS) is a structured documentation system that defines the relationships and hierarchy of organizational charts, management charters, policies, and procedures of Litton ATD. They recognized that the documentation of their management system was old and the method for updating it had become obsolete. Therefore, they instituted an Integrated Management System structure in 1985, which started the process of updating and converting its management system documentation and defining how business has been done to date.

Under the "old" system, there were 28 manuals defining division level policy/procedures and functional directives, procedures, and work instructions. This produced a multitude of undesirable situations and problems such as lack of common structure of subject matter, conflicting management accountabilities/responsibilities, too much to read and comprehend, too many levels of documentation to control, etc.

Under the "new" system, Litton ATD developed one version to follow, developed a system of elements with relationships and hierarchy, provided an organizational breakdown structure for organizational charts and management charters, provided a topical breakdown structure for policies, directives, and procedures and established a series of defined manuals to contain the various system elements in the proper hierarchical relationships.

The Litton ATD IMS was completed in 1987. With the IMS, Litton ATD has been able to quickly evaluate and document its management system to various DoD initiatives such as Contractor System Status Reviews (CSSR), Best Manufacturing Practices (BMP), Manufacturing Management/Production Capability Reviews (MM/PCR), and Total Quality Management (TQM).

FIRST ARTICLE MASTER SCHEDULING COMMITTEE

Litton ATD has implemented a program planning and control system for "first article" products called FAMSCO (First Article Master Scheduling Committee).

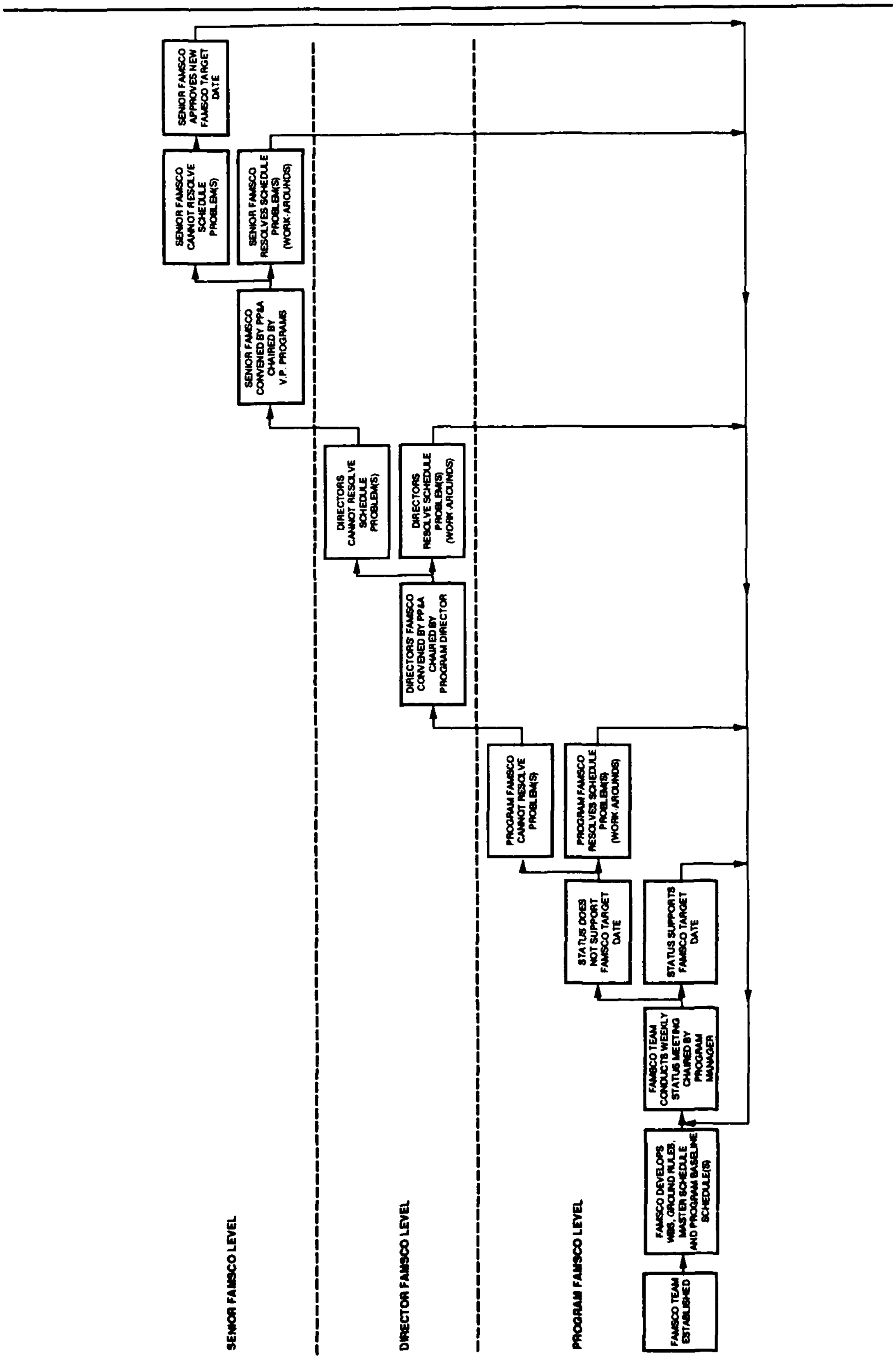
The FAMSCO is chartered to apply a formal process of review and accountability to each major "first article" product developed at Litton ATD. A FAMSCO is identified at the Program management level, the Director level, and the Senior level at Litton ATD. Problems and resolutions escalate through this hierarchy, as necessary, to exercise control of the first article.

The Program FAMSCO team (first tier of the hierarchy) consists of the Program Manager (Chairman), the Chief Project Engineer, and representatives from Operations, Product Assurance, Program Planning, Procurement, and the appropriate engineering disciplines. The Director FAMSCO team consists of the Program Director and the Directors of Operations, Product Assurance, etc. The Senior FAMSCO team (top tier) consists of the vice presidents of these departments.

Each Program FAMSCO team meets regularly on a weekly basis in a dedicated FAMSCO room. The committee is responsible for developing work breakdown structures, program master schedule, baseline schedules, and ground rules. They review various work arounds to resolve problems, issue and monitor action items, and convene the Director and Senior level FAMSCO, when required.

The FAMSCO process is supported by two PC based planning and scheduling systems, PROMIS and MACPROJECT II. They provide a cost effective approach to schedule development, statusing, "what if" scenarios, and critical path analysis.

The FAMSCO planning and control process has developed into a proven success for Litton ATD and has been essential in improving their "first article" transition from R & D to production.



FAMSCO PROCESS

DIVISION MASTER PLANNING PROCESS

Litton ATD has implemented a high level planning tool for division and corporate level planning within the Operations and Engineering structure. The key purpose of the division master planning process is to focus on forecasting, schedules, deliveries, delays, sales, and business management issues with which they must comply.

Out of the division master planning initiatives has emerged the Division Master Plan (DMP), which appears to be a clearly proven program management tool and is highly credited for their program planning and control success. The DMP formalizes the Litton ATD planning and control needs, builds management accountability into the process, enables early problem identification and reporting, and utilizes the efficiencies gained through personal computer based software, i.e., LOTUS 1-2-3. The operations portion of the DMP provides the framework for developing the master production schedule.

The division master planning process includes regularly scheduled weekly and monthly meetings and reporting. The weekly schedule includes: sales analysis and reporting, sales briefing, and issuance/monitoring action items. The monthly schedule includes production planning review of all programs, contractor delinquency analysis, spares breakdown, and issuance/monitoring of action items associated with the performance of the plan.

Further, division master planning is responsible for the development, maintenance, and distribution of the DMP. All "input" to the DMP must be approved by the cognizant directors and vice presidents. The five-year DMP is implemented the first quarter of the fiscal year and updated the third quarter. In the event of schedule slippage, division master planning provides contractual delinquency reporting to the executive staff level. The programs organization defines/monitors corrective actions.

3.6 TRANSITION PLAN

BEST MANUFACTURING PRACTICES IMPLEMENTATION

Litton corporate policy requires that DoD 4245.7-M and Best Practices (NAVSO P-6071) be invoked in all DoD contracts and that all divisions tailor compliance to their specific business through written policies and procedures. Litton ATD has established an effective program management approach to implementing this policy.

The program is being implemented in two phases. Under Phase I, from April 1987 thru September 1987, a director level task team was established which evaluated various implementation approaches, issued a division policy document, and initiated awareness training. Under Phase II, from October 1988 to September 1989, BMP implementation became a program with a full time program manager and an established organization. All templates in DoD 4245.7-M and NAVSO P-6071 were reviewed against ATD policies and procedures. Corrective actions were assigned for areas of non-compliance. All actions were completed and 23 new policy and procedure documents were issued to achieve full compliance by 1 March 1989. A formal training program was established for project management and functional personnel. An initial

Program Management Handbook was approved by the division president. The handbook provides specific policies and procedures on how each template requirement is implemented by ATD. Compliance audits are being conducted on company program offices and corrective actions are being identified to update and validate the handbook. The validated handbook will be released under the division president's signature, completing Phase II in September 1989.

A key to the success of the BMP implementation is the obvious strong top level commitment and support. It is a major sub-task of the Litton ATD Total Quality Management (TQM) program. All Navy programs are now required to be structured, funded, and implemented in accordance with DoD 4245.7M and NAVSO P-6071 and all the services are reviewing and assessing existing programs against the templates. Litton ATD has structured their programs in a similar fashion.

SECTION 4

PROBLEM AREAS

4.1 DESIGN

LOW TEMPERATURE FAILURE PREDICTIONS

MIL-HDBK-217 predicts that system failure rates, when extrapolated below 25 degrees C, will decrease with decreasing temperature. Litton ATD's reliability engineers, however, have postulated that system failure rates will increase as ambient temperatures drop significantly below 25 degrees C due to decreased design margins and increased probability of out-of-tolerance conditions. Scientific and statistical approaches were investigated as a way to derive the extension from experimental data. The scientific approach is dependent upon enormous amounts of test data and analysis. This approach was viewed as impractical, due to the time and effort required. The statistical approach that Litton ATD chose assumed that predictions would parallel measured data and that the failure rate is semi-logarithmic, with the process only dependent upon failure data.

Litton ATD's experimental data supported their postulate. The resulting ratios derived are only applicable to Litton ATD equipment. However, the methodology can be used by other manufacturers. In addition, the prediction methodology is only applicable at the Weapons Replaceable Assembly (WRA)/Line Replaceable Unit (LRU) level.

The results of this effort indicate that Litton ATD has derived a failure prediction methodology for low temperature operation that should result in more accurate failure rate predictions as a function of mission profiles.

APPENDIX A

TABLE OF ACRONYMS

Acronym	Definition
ASIC	Application Specific Integrated Circuit
ATD	Applied Technology Division
BMP	Best Manufacturing Practices
CAD	Computer-Aided Drafting
CAE	Computer-Aided Engineering
CASE	Computer-Aided Software Engineering
CSSR	Contractor System Status Review
DMP	Division Master Plan
EO	Electro-Optic
FAMSCO	First Article Master Scheduling Committee
HMD	Hybrid Microwave Devices
IMS	Integrated Management System
LRU	Line Replaceable Unit
MIC	Microwave Integrated Circuit
MM/PCR	Manufacturing Management/Production Capability Review
PCA	Printed Circuit Assembly
PP&A	Program Planning and Analysis
PWB	Printed Wiring Board
UP/DATE	Universal Production/Depot Automatic Test Equipment
UUT	Unit Under Test
UV	Ultra-Violet
SRA	Shop Replaceable Assembly
TQM	Total Quality Management
WRA	Weapons Replaceable Assembly

APPENDIX B

BMP REVIEW TEAM

Team Member	Agency	Role
Alan Criswell (215) 897-6684	**Naval Industrial Resources Support Activity** Philadelphia, PA	**Team Chairman**
Jim Brining (317) 353-7950	**Naval Avionics Center** Indianapolis, IN	**Team Leader** Design/Test
Dave Zeph (317) 353-7961	**Naval Avionics Center** Indianapolis, IN	
Larry Robertson (812) 854-3085	**Naval Weapons Support Center** Crane, IN	**Team Leader** Production/Facilities
Jerry Sergeant (309) 782-7800	**US Army Industrial Engineering Activity** Rock Island, IL	
Rick Purcell (202) 692-3383	**Office of the Assistant Secretary of the Navy (S&L)** (RM&QA-PI) Washington, D.C.	**Team Leader** Management/Logistics
Larry Halbig (317) 353-7075	**Naval Avionics Center** Indianapolis,IN	

APPENDIX C

PREVIOUSLY COMPLETED SURVEYS

BMP surveys have been conducted at the companies listed below. Copies of survey reports for any of these companies may be obtained by contacting:

Best Manufacturing Practices Program
Office of the Assistant Secretary of the Navy
(Shipbuilding and Logistics)
Attn: Mr. Ernie Renner, RM&QA
Washington, DC 20360-5000
Telephone: (202) 692-0121

COMPANIES SURVEYED

Litton
Guidance & Control Systems Division
Woodland Hills, CA
October 1985

Honeywell, Inc.
Underseas Systems Division
Hopkins, MN
January 1986

Texas Instruments
Defense Systems & Electronics Group
Lewisville, TX
May 1986

General Dynamics
Pomona Division
Pomona, CA
August 1986

Harris Corporation
Government Support Systems Division
Syosset, NY
September 1986

IBM Corporation
Federal Systems Division
Owego, NY
October 1986

Control Data Corporation
Government Systems Group
Minneapolis, MN
December 1986

Hughes Aircraft Company
Radar Systems Group
Los Angeles, CA
January 1987

ITT
Avionics Division
Clifton, NJ
September 1987

Rockwell International Corporation
Collins Defense Communications
Cedar Rapids, IA
October 1987

UNISYS
Computer Systems Division
St. Paul, MN
November 1987

Motorola
Government Electronics Group
Scottsdale, AZ
March 1988

General Dynamics
Forth Worth Division
Fort Worth, TX
May 1988

Texas Instruments
Defense Systems & Electronics Group
Dallas, TX
June 1988

Hughes Aircraft Company Missile Systems Group Tucson, AZ August 1988	Bell Helicopter Textron, Inc. Fort Worth, TX October 1988
Litton Data Systems Division Van Nuys, CA October 1988	GTE C^3 Systems Sector Needham Heights, MA November 1988
McDonnell Aircraft Comany St. Louis, MI January 1989	Northrop Corporation Aircraft Division Hawthorne, CA March 1989

Information gathered from all BMP surveys is included in the Best Manufacturing Practices Management Information System (BMP-MIS). Additionally, a calendar of events and other relevant information are included in this system. All inquires regarding the BMP-MIS may be directed to:

Director, Naval Industrial Resources Support Activity
Attn: BMP-MIS System Administrator
Bldg. 75-2, Room 209, Naval Base
Philadelphia, PA 19112-5078
Telephone: (215) 897-6684